CLAIMS

What is claimed is:

1. A method of storing hydrogen comprising: contacting gaseous hydrogen with an imide having one or more cations other than hydrogen, said one or more cations forming at least two distinct compounds different from said imide upon reaction with hydrogen.

2. The method of Claim 1 wherein said at least two distinct compounds comprise an amide and a hydride.

3. The method of Claim 1 wherein said imide is represented by $M^{c}(NH)^{-2}{}_{c/2}$, where M represents at least one cationic species other than hydrogen and c represents an average valence state of M.

4. The method of Claim 1 wherein said at least two distinct compounds comprise a first compound represented by $MI^{d}(NH_2)_d{}^{-1}$ (amide) and a second compound represented $MII^{f}H_f$ (hydride), where MI and MII respectively represent cationic species or a mixture of cationic species other than hydrogen, and d represents an average valence state of MI and f represents an average valence state MII.

5. The method of Claim 1 wherein said imide is lithium imide represented by Li_2NH and said distinct compounds comprise a first compound represented by $LiNH_2$, and a second compound represented by LiH.

6. The method of Claim 3 wherein M comprises an element selected from the group consisting of Ba, Ca, Eu, La, Li, Mg, Sr, Th and mixtures thereof.

7. The method of Claim 2 wherein said imide is represented by the formula MgNH, said amide is represented by the formula $Mg(NH_2)_2$ and said hydride is represented by the formula MgH_2.

8. The method of Claim 4 wherein said M, MI and MII are each elements independently selected.

9. The method of Claim 8 wherein said M, MI and MII are each elements independently selected from the group consisting of CH_3, Al, As, B, Ba, Be, Ca, Cd, Ce, Cs, Cu, Eu, Fe, Ga, Gd, Ge, Hf, Hg, In, K, La, Li, Mg, Mn, Na, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Se, Si, Sm, Sn, Sr, Th, Ti, Tl, W, Y, Yb, Zn, Zr, and mixtures thereof.

10. The method of Claim 8 wherein said M, MI and MII are each elements independently selected from the group consisting of Ba, Be, Ca, Cs, Eu, In, K, La, Li, Mg, Na, Ni, Rb, Sm, Sr, Yb, and mixtures thereof.

11. The method of Claim 8 wherein said M, MI and MII are each elements independently selected from the group consisting of Ba, Ca, Eu, La, Li, Mg, Sr, Th, and mixtures thereof.

12. The method of Claim 8 wherein said M, MI and MII are each elements independently selected from the group consisting of Ba, Ca, Si, Sr, Th, Ti, Zr, and mixtures thereof.

13. The method of Claim 8 wherein said M, MI and MII are each elements independently selected from the group consisting of Al, Ba, Be, Ca, Ce, Cs, Eu, Ga, Gd, In, K, La, Li, Mg, Mn, Na, Nd, Pb, Rb, Si, Sm, Sn, Sr, Y, Yb, Zn, and mixtures thereof.

14. The method of Claim 8 wherein M, MI and MII are each elements independently selected from the group consisting of Al, Be, B, Mg, Li and mixtures thereof.

15. The method of Claim 1 wherein before said contacting, said at least two distinct compounds are mixed together to form said imide; and then said imide is reacted with H_2 in said contacting step in a reversible process.

16. The method of Claim 15 wherein said compounds are mixed together by milling.

17. A method of forming an imide hydrogen storage material represented by the formula, $M^c(NH)^{-2}{}_{c/2}$, comprising: reacting an amide $MI^d(NH_2)_d{}^{-1}$ with a hydride MII^fH_f; where M, MI and MII represent cationic species other than hydrogen; and c, d, and f respectively represent average valence states of respectively said M, MI and MIII.

18. The method of Claim 17 where the amide is lithium amide, the hydride is lithium hydride, and the imide is lithium imide.

19. The method of Claim 17 wherein M, MI and MII are each independently selected.

20. A method of making an imide hydrogen storage material represented by $M^c(NH)^{-2}{}_{c/2}$, comprising: reacting a nitride represented by the formula $MIII^gN_{3/g}$ with an amide represented by $MI^d(NH_2)_d{}^{-1}$, where M, MI and MIII represent cationic species other than hydrogen, and c, d and g represent average valence states of respectively said M, MI and MIII.

21. A method for forming an imide hydrogen storage material represented by $M^c(NH)^{-2}{}_{c/2,}$ comprising: heating an amide compound

represented by $MI^{d}(NH_2)_d^{-1}$ for a time and at a temperature sufficient to produce reaction product comprising said imide material and ammonia (NH_3); and separating at least a portion of said ammonia from said reaction product to provide said imide material; where M and MI represent cationic species other than hydrogen, and where c and d represent average valence states of respectively M and MI.

22. A hydrogen storage composition having a hydrogenated state and a dehydrogenated state:

(a) in said hydrogenated state, said composition comprises an amide and a hydride; and

(b) in said dehydrogenated state, said composition comprises an imide.

23. The composition of Claim 22 wherein said imide is represented by the formula Li_2NH.

24. The composition of Claim 22 wherein said amide is represented by the formula $LiNH_2$.

25. The method of Claim 22 wherein said hydride is represented by the formula LiH.

26. A method of producing a source of hydrogen gas comprising: liberating hydrogen from a hydrogenated composition comprising an amide

and a hydride by heating said composition at an elevated temperature sufficient to evolve hydrogen gas therefrom thereby producing dehydrogenated product; and regenerating said hydrogenated composition by exposing said dehydrogenated product to hydrogen gas.

27. The method of Claim 26 wherein said dehydrogenated product comprises imide.

28. The method of Claim 26 wherein said liberating of hydrogen is conducted at an elevated temperature greater than about 125°C.

29. The method of Claim 26 wherein said liberating of hydrogen is conducted at an elevated temperature greater than about 150°C.

30. The method of Claim 26 related when said regenerating is conducted at an elevated pressure.

31. The method of Claim 26 wherein said regenerating is conducted at an elevated pressure greater than about 10 kPa.

32. The method of Claim 26 wherein said regenerating is conducted at an elevated pressure greater than about 200 kPa.